Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	Interference from a PP link system to a BFWA PMP system (co-channel case; frequency range 2: 23.5 to 43.5 GHz).
Date Submitted	**2002-04-24**
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Re:	Amendment to Coexistence Recommended Practice IEEE 802.16.2-2001
Abstract	This paper provides the results of an analysis of scenarios in which BFWA PMP systems may receive interference from point links operating in adjacent areas, on the same channels. The point-to- point links are assumed to be individually licensed and to have "protected" status. However, the PMP system will not usually benefit in this way, so that higher levels of interference above the normal acceptable threshold level may occasionally be acceptable.
Purpose	To provide simulation results and draft coexistence guidelines for scenarios 3 and 4 in IEEE C802/16.2a-02/06 (interim considerations from simulations).
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Release	
Patent Policy and Procedures	

Interference from a PP link system to a BFWA PMP system (co-channel case; frequency range 2: 23.5 to 43.5 GHz).

This paper provides the results of an analysis of scenarios in which BFWA PMP systems may receive interference from point links operating in adjacent areas, on the same channels. The point- to- point links are assumed to be individually licensed and to have “protected” status. However, the PMP system will not usually benefit in this way, so that higher levels of interference above the normal acceptable threshold level may occasionally be acceptable. The scenarios correspond to nos. 3 and 4 in IEEE C802.16.2a-02/06 [1].

The analysis is carried out at two frequencies; 25 GHz and 38 GHz. Relevant PP system parameters are taken from the results of an earlier IEEE 802.16 study and can be found in [4].

Interference scenarios

In this case, the interferer is a single PP link station transmitter (the case where there are multiple PP links is described in a separate paper). Since there is a single interferer, a simple worst-case analysis is appropriate.

In the case of a typical PMP BS, the antenna beam-width and height above surrounding terrain are such that terrain losses (over and above free space) for distances less than the horizon distance cannot be relied on. Therefore, all such paths for the worst - case analysis should be assumed to be clear, line of sight.

For over the horizon paths, additional losses above free space will occur. The calculation of the excess loss is complex and terrain dependent. A methodology for estimating such losses can be found in ITU –Rec.452 [2]. The calculation of horizon distance can be found in the IEEE 802.16.2 Recommended Practice [3].

The interference model for the case where the BS is the victim is shown in fig 1. A corresponding model for the SS case is shown in fig 2.

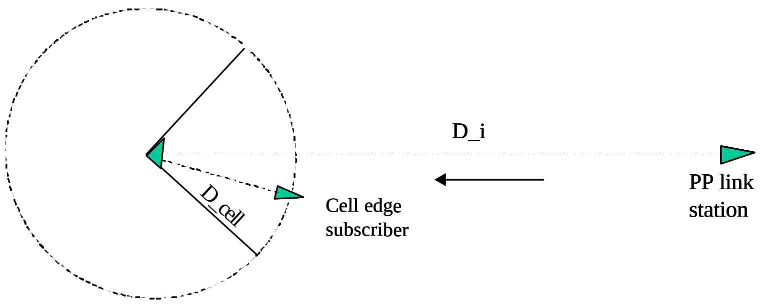

Fig. 1 Interference geometry (PP link to PMP BS)

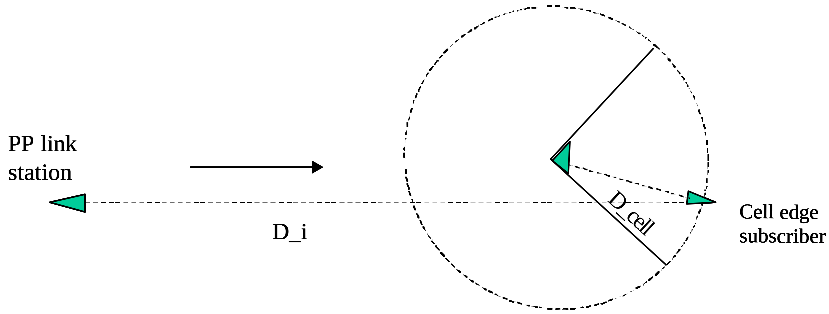

Fig. 2 Interference geometry (PP link station to PMP SS)

The PMP cell is shown as a circle. A nominal cell radius of 5km is assumed. The victim station is a BS or an SS within the sector. The distance from the BS or SS to the interfreing link station is D_i. The following parameters are assumed for the analysis:

Parameter	**Value**	**Note**
PMP cell radius (D_cell)	5km	
Typical PP link length	Up to 5km (25 GHz) Up to 3km (38 GHz)	From [4]
Frequency	25 GHz / 38 GHz	PP link antenna patterns for these frequencies are available in [5]
BS antenna gain (25/ 38 GHz)	19dBi / 20 dBi	Typical for 90 degree sector antenna
SS antenna gain (25/ 38 GHz)	36dBi / 38dBi	Typical values for narrow beam antennas
Link antenna gain (25/ 38 GHz)	40 dBi / 42dBi (Note 1)	From [4]
Nominal PP Rx input level	-73dBm	Assuming 16 QAM modulation
Note 1: The range of values proposed in [4] is 40 - 42dB		

Table 1: Parameters for PP to PMP interference scenarios

Results

The results of the analysis are summarised in table 2 (interference to BS) and table 3 (interference to SS). The threshold for acceptable interference is taken as –100 dBm, corresponding to –114.5dBm/ MHz in a 28 MHz channel. The tables show the level of interference for various combinations of PP link length, interference path distance (D_I) and PP link antenna offset angle. Line of sight propagation is assumed. Acceptable results are highlighted in the tables.

interference from PP to BS Rx (co-channel, adjacent area)			25 GHz	25 GHz	25 GHz		38 GHz	38 GHz	38 GHz
Frequency GHz		25	25.0	25.0	25.0		38.0	38.0	38.0
Tx power, max	dBm	26							
link path length km	D_link		**5.0**	**5.0**	**10.0**		**3.0**	**3.0**	**10.0**
link path loss dB (25 GHz)		-123-20log d	-137.0	-137.0	-143.0				
link path loss dB (38 GHz)		-126.4-20log d					-136.0	-136.0	-146.4
interference path length, km	D_i		**7.00**	**10.00**	**20.00**		**5.0**	**7.0**	**20.0**
interference path loss dB			-139.9	-143.0	-149.0		-140.4	-143.3	-152.5
Link antenna gain dBi		40	40	40	40		42	42	42
BS antenna gain dBi		19	19	19	19		20	20	20
SS antenna gain dBi		36	36	36	36		38	38	38
wanted PP Rx input, 16 QAM, dBm		-73	-73.0	-73.0	-73.0		-73.0	-73.0	-73.0
PP Tx power, no fade dBm			-16.0	-16.0	-10.0		-21.0	-21.0	-10.6
interference power, no fade, dBm			-96.9	-100.0	-100.0		-99.4	-102.4	-101.0
Less off axis RPE factor (25 GHz)	3 degrees	-8	-104.9	-108.0	-108.0		n/a	n/a	n/a
	5.8 degrees	-19	-115.9	-119.0	-119.0		n/a	n/a	n/a
	10 degrees	-22	-118.9	-122.0	-122.0		n/a	n/a	n/a
Less off axis RPE factor (38 GHz)	2 degrees	-8	n/a	n/a	n/a		-107.4	-110.4	-109.0
	4 degrees	-19	n/a	n/a	n/a		-118.4	-121.4	-120.0
	7 degrees	-25	n/a	n/a	n/a		-124.4	-127.4	-126.0

Table 2: PP to BS Interference (25 and 38 GHz)

interference from PP to SS Rx (co-channel, adjacent area)			25 GHz	25 GHz	25 GHz		38 GHz	38 GHz	38 GHz
Frequency GHz		25	25.0	25.0	25.0		38.0	38.0	38.0
Tx power, max	dBm	26							
link path length km	D_link		**5.0**	**5.0**	**10.0**		**3.0**	**3.0**	**10.0**
link path loss dB (25 GHz)		-123-20log d	-137.0	-137.0	-143.0				
link path loss dB (38 GHz)		-126.4-20log d					-136.0	-136.0	-146.4
interference path length, km	D_i		**50.00**	**80.00**	**150.00**		**30.0**	**45.0**	**150.0**
interference path loss dB			-157.0	-161.1	-166.5		-156.0	-159.5	-170.0
Link antenna gain dBi		40	40	40	40		42	42	42
BS antenna gain dBi		19	19	19	19		20	20	20
SS antenna gain dBi		36	36	36	36		38	38	38
wanted PP Rx input, 16 QAM, dBm		-73	-73.0	-73.0	-73.0		-73.0	-73.0	-73.0
PP Tx power, no fade dBm			-16.0	-16.0	-10.0		-21.0	-21.0	-10.6
interference power, no fade, dBm			-97.0	-101.1	-100.5		-97.0	-100.5	-100.5
Less off axis RPE factor (25 GHz)	3 degrees	-8	-105.0	-109.1	-108.5		n/a	n/a	n/a
	5.8 degrees	-19	-116.0	-120.1	-119.5		n/a	n/a	n/a
	10 degrees	-22	-119.0	-123.1	-122.5		n/a	n/a	n/a
Less off axis RPE factor (38 GHz)	2 degrees	-8	n/a	n/a	n/a		-105.0	-108.5	-108.5
	4 degrees	-19	n/a	n/a	n/a		-116.0	-119.5	-119.5
	7 degrees	-25	n/a	n/a	n/a		-122.0	-125.5	-125.5

Table 3: PP to SS interference (25 and 38 GHz)

Results when the BS is the victim

In the case where the BS is the victim, it can be seen that for the worst PP link pointing direction, a system spacing of the order of 10 km is sufficient. For unusually long link paths (longer than proposed in [4]), this distance increases, but a small pointing offset is sufficient to achieve an acceptable result. There is only a small difference between the 25 GHz and 38 GHz results.

It must be noted that in practice there may well be several potential victim BSs and a calculation must be carried out for each one separately.

Results when the SS is the victim

In the case where the SS is the victim, the level of interference is greater than for the BS case and the number of stations that may interfere is much higher. Although the SS antenna beam-width is narrower, there are many stations distributed across the cell/ sector, so that the probability of interference may still be high and the reduction of interference due to antenna pointing offset may not be as effective as might be hoped. Thus, in the table, only the PP antenna pointing - offset is considered.

For typical PP link lengths a system spacing of 50 – 80 km is required. In practice this will be comparable with or less than the typical horizon distance. An advantage in the SS case is that the antenna heights are generally much lower than for the BS. Therefore the horizon distance will typically be much shorter and excess losses more likely at reasonable distances.

As for the BS case, the difference between the 25 GHz and the 38 GHz results is negligible.

In both of the above cases, the victim system does not have "protected" status, so that coordination is not essential. It will be sufficient to set a system spacing that gives an acceptably low probability of interference above the normally acceptable threshold.

Conclusions for the PP to PMP co-channel scenarios

Interference Scenario	Frequency	Guideline	Notes
PP link station to BS	25 GHz	10km system spacing, with some additional isolation due to PP antenna offset for longer links (over 5km at 25 GHz or over 3km at 38 GHz).	Multiple victim BSs may have to be considered
PP link station to BS	38 GHz	10km system spacing, with some additional isolation due to PP antenna offset for longer links (over 5km at 25 GHz or over 3km at 38 GHz).	Multiple victim BSs may have to be considered
PP link station to SS	25 GHz	50- 80km system spacing required. OR where SS antennas are low, high over the horizon losses may dominate (even for shorter distances)	SS interference is worst case and dominates unless terrain losses can be relied on

PP link station to SS	38 GHz	50 - 80km system spacing required. OR where SS antennas are low, high over the horizon losses may dominate (even for shorter distances)	SS interference is worst case and dominates unless terrain losses can be relied on

Table 4: Summary of results

A study carried out in ETSI TM4 also partly covers this topic. Further information can be found in [6].

References

[1] IEEE C802.16.2a-02/06; "Interim considerations from simulations".
[2] Rec. ITU-R P.452.9; "Prediction procedure for the evaluation of microwave interference between stations on the surface of the earth at frequencies above about 0.7 GHz."
[3] IEEE 802.16.2-2001; "Recommended Practice for coexistence of Fixed Broadband Wireless Access Systems."
[4] IEEE C802.16.2a-01/06; "System parameters for point to point links for use in Coexistence Simulations (revision 1)"
[5] IEEE 802.16.2-01/14; "Proposed Antenna Radiation Pattern Envelopes for Coexistence Study".
[6] ETSI Technical Report TR 101 853 v1.1.1 (2000-10); "Fixed Radio Systems; Point to point and point to multipoint equipment; Rules for the coexistence of point to point and point to multipoint systems using different access methods in the same frequency band."

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